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TL8-30V

INSTRUMENT DIVISION

POWER SUPPLY

DOCUMENT NO. 120025-01

OPERATING AND SERVICE MANUAL

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SYSTRON DONNER
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Concord, California 94518

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June, 1985

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TABLE OF CONTENTS

CHAPTER		PAGE
1	DESCRIPTION	
1.1	Introduction	1-1
1.2	Description	1-1
1.3	General Features	1-1
1.3.1	Constant Voltage Mode	1-1
1.3.2	Automatic Current Limiting.	1-1
1.3.3	Automatic Overvoltage Protection	1-1
1.4	Precautionary Measures	1-1
1.4.1	Wire Size	1-1
1.4.2	Voltage Regulator & Inverter Inputs	1-2
1.4.3	System Considerations	1-2
2	OPERATION	
2.1	Electrical Connections	2-1
2.1.1	Power Input	2-1
2.1.2	Front Panel Output	2-1
2.2	Controls	2-1
2.2.1	Front Panel	2-1
2.2.2	Internal	2-1
2.3	Operation	2-1
2.3.1	Grounding	2-1
2.3.2	Power On	2-1
2.3.4	Warm-Up	2-1
3	THEORY OF OPERATION	
3.1	General	3-1
3.1.1	Primary Input	3-1
3.1.2	Reference Supplies	3-1
3.1.3	Series Regulator	3-1
3.1.4	Voltage (Error) Amplifier	3-1
3.1.5	Current Limit Circuit	3-1
3.2	Optional Features	3-1
3.2.1	Overvoltage Protection	3-1
4	MAINTENANCE	
4.1	General	4-1
4.2	Loads and Interconnections	4-1
4.3	Troubleshooting	4-1
5	CALIBRATION	
5.1	General	5-1
5.2	Test Equipment Required	5-1
5.3	Calibration Procedure	5-1
6	REPLACEABLE PARTS	
6.1	Introduction	6-1
6.2	Part Ordering Information	6-1
6.3	Parts Lists	6-1
	Shipping Assembly	6-4
	Chassis Assembly	6-4
	Heatsink Assembly	6-4
	Front Panel Assembly	6-4
	PC Board Assembly	6-5
	Meter Assembly	6-10

LIST OF TABLES

TABLE		PAGE
1-1	Specifications	1-2
2-1	AC Input Wire Size	2-1
2-2	Front Panel Controls	2-1
6-1	Manufacturer's Code-To-Name Index	6-2

APPENDICES

Schematic

CHAPTER 1

DESCRIPTION

1.1 INTRODUCTION

The TL8-3 Triple Output Lab Series Power Supply is a flexible and dependable source of DC power, which can be used to meet a variety of needs. These needs may range in scope from inspection and production testing, to laboratory bench testing and systems applications.

The wide range of outputs available makes these units well suited for use as basic laboratory power sources. The ability to provide power packaged in minimum space with high reliability meets the demands of most systems and laboratory requirements.

This instruction manual provides general characteristics and specifications, operating procedures, theory of operation, maintenance and troubleshooting, calibration, parts list and related schematics for the TL8-3 Power Supply.

1.2 DESCRIPTION

The TL8-3 Power Supply is a multiple output unit specifically designed for laboratory applications utilizing IC circuitry. Independent output voltages are provided to allow simultaneous power to be supplied to a typical IC (digital or analog) breadboard circuit and two additional independent power sources for typical auxiliary circuitry. Output voltage and currents may be independently monitored.

A variety of voltage and current outputs are available providing unexcelled operational versatility and flexibility. This output flexibility permits the user to have complete convenience in filling laboratory power requirements.

The Triple Lab Power Supply utilizes silicon semiconductors permitting operation at its maximum temperature rating without derating.

1.3 GENERAL FEATURES

Three independently adjustable outputs, automatic electronic current limiting, no turn on/turn off transients and three independent dual range meters are featured in this Power Supply. An Overvoltage Protection (OV) Option is also available in the Model TL8-3. Independent metering for each output allows simultaneous monitoring of voltages and current. A Front Panel lamp indicates an overload condition on any of the three outputs. Coarse and fine output controls for each output permits precise adjustability.

1.3.1 Constant Voltage Mode

A constant voltage is maintained across the output terminals at any preset value from zero to rated voltage output, provided that the load does not draw more than the rated output current.

1.3.2 Automatic Current Limiting

Short circuit protection is provided by the Automatic Current Limiting circuit which limits the maximum output current under all load conditions. The point at which automatic current limiting oc occurs is at approximately 110% of the maximum rated current otuput of the unit. In the event of a short circuit, the output voltage will drop to zero, and will return to its previous level only upon removal of the short circuit.

1.3.3 Automatic Overvoltage Protection (Optional Feature, "A" Output Only)

Automatic Overvoltage (OV) protections prevents the output voltage from exceeding the programmed voltage and can be internally adjusted through an access slot in the cover.

1.4 PRECAUTIONARY MEASURES

1.4.1 Wire Size

To assure proper regulation under all load conditions, and to prevent severe distortions of the AC line voltage, it is very important to take into consideration the physical size and current handling capabilities of the input power line. Serious losses in regulation and an increase in ripple may result from underrated or overloaded AC input lines. The maximum AC inpedance from the breaker bos to the Power Supply input should not exceed 0.75 ohms.

1.4.2 Voltage Regulator and Inverter Inputs

Do not use voltage regulators or inverters as a primary power source. The outputs of these devices are usually not sinusoidal in nature, and if used as the AC source for the Power Supply, may cause serious loss of regulation of the Power Supply output. Capacitive input filtering used for semiconductor power supplies require charging to the peak of the rectified AC wave which nonsinusoidal AC sources may not provide.

1.4.3 System Considerations

In systems applications it is recommended that each Power Supply input power line be run separately to the AC distribution box, in order to minimize cross coupling and interaction between equipment. To keep the AC ripple in the output to a minimum, it is recommended that the AC input cables should not be run in close proximity to the output load cables.

The specifications cited herein for regulation and ripple can be readily attained on every Power Supply providing the porper method of measurement is employed. The major consideration is that the highly stable meter and oscilloscope, specified in the calibration procedures, must be connected to the sensing terminals and not the load terminals. The reason for this precaution is that the voltage drop between the load terminals and sensing terminals will yield an inaccurate regulation ripple measurement.

TABLE 1-1 SPECIFICATIONS

ELECTRICAL SPECIFICATIONS	
Input:	105-125 VAC, 47-420 Hz; 105-115 VAC, 50 Hz.
Output[1]:	Triple floating; isolated from ground, 300 VDC maximum.
(A)	0 to +8 VDC, 3A; rating reduces to 2A at 0 VDC.
(B)	0 to +32 VDC, 1A; rating reduces to 0.5A at 0 VDC.
(C)	0 to -32 VDC at 1A; rating reduces to 0.5A at 0 VDC.

[1] At maximum line voltage condition, the total output current should not exceed 80% of total allowable current.

TABLE 1-1 SPECIFICATIONS (Cont'd)

Model	Volts	Amps	Impedance*
TL8-3	0 to +8 VDC	0 to 3	0.003Ω
or	0 to +32 VDC	0 to 1	0.010Ω
TL8-3OV	0 to -32 VDC	0 to 1	0.010Ω

*Nominal, DC-1 kHz

All outputs are referenced to a common return electrically isolated from chassis ground.

Regulation, Line:	0.02% or 2 mV[2], for 105-125 VAC line change, at any output within specifications.
Regulation, Load:	0.02% or 5 mV[2], no load to full load, at any output within specifications.
Ripple:	500 μV RMS; 3 mV p-p. (10 MHz) (20 mV p-p @420 Hz input).
Stability:	0.1% or 10 mV[2], for 8-hours after warm-up. Measured at constant line voltage, load and ambient temperature.
Temperature Coefficient:	0.02% +400 μV/°C.
Temperature Range:	0°C to +40°C.
Recovery Time:	50 μs to within 0.05% or 15 mV[2] or output voltage, for 80% step change in rated load. (.2 load to full load).
Short Circuit Protection:	Automatic Electronic Current Limiting.
AC Power Input Protection:	Fuse.
Voltage Adjustment Range:	Continuously adjustable varinier controls.

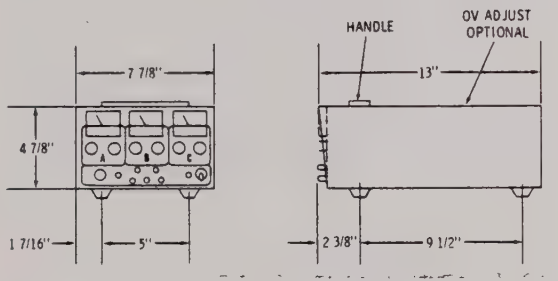
GENERAL & PHYSICAL SPECIFICATIONS

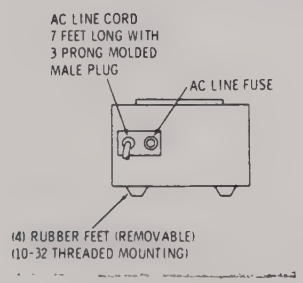
Design Principle:	Precision Series Pass Regulation.
Operation Mode:	Constant voltage with automatic current limiting.
Controls	
Voltage:	Coarse and Fine; 0 to rated output; front panel. Resolution 1 mV on fine control.

[2] Whichever is greater.

TABLE 1-1 SPECIFICATIONS (Cont'd)

Controls (Cont'd)	
Input Power:	Front Panel switch and indicator, AC ON.
Metering:	Three combination Volt/ Ammeters with Front Panel selector switch.
Front Panel Terminals:	Positive Output A, Positive Output B, Negative Output C, Common Return, Chassis Ground.
Overvoltage Protection:	Internal adjustable overvoltage protection is available, as a factory option on output (0 to +8 VDC).
Size:	7-7/8" D x 4-7/8" H x 12-9/16" D.
Weight:	16 lbs.





CHAPTER 2

OPERATION

2.1 ELECTRICAL CONNECTIONS

2.1.1 Power Input

A heavy duty 3 wire line cord and molded plug with grounding prong provides a path for input power to the unit.

The power handling ability of the AC power lines feeding AC power to the line cord must be considered, as serious losses in regulation and substantial increases in ripple can occur as a result of insufficient power handling capacity of these lines. The AC impedance from the breaker box to the power supply input connector should not exceed 0.75 ohms. All AC power line connections must be securely tightened, and any movable electric contact surface (such as the wiper arm of a variable transformer) should be kept clear of impedance producing oxide coatings.

Care should be exercised in selecting the proper wire size for the AC input lines. The Figures listed in Table 2-1 will serve as a guide in making this selection.

TABLE 2-1 AC INPUT WIRE SIZE

Length of Run (Single Lead)	Wire Size (AWG Standards)
10 feet or less	12
10 feet to 20 feet	10
20 feet to 50 feet	8
50 feet to 100 feet	6

2.1.2 Front Panel Output

Five binding post terminals mounted on the Front Panel provide output and ground connections.

2.2 CONTROLS

2.2.1 Front Panel

The Front Panel Controls for the Model TL8-3 are listed in Table 2-2.

TABLE 2-2 FRONT PANEL CONTROLS

Name	Function
AC POWER (toggle switch)	Toggle switch, controls input power.
VOLTAGE ADJUST (Coarse)	Potentiometer, adjusts voltage output.
VOLTAGE ADJUST (Fine)	Potentiomater, adjusts voltage output.
METER SELECT (V, I)	Rotary switch, controls functions of output meters. (2-position).

2.2.2 Internal

All internal control settings have been factory preset, and require no additional adjusting. However, if it should become necessary to adjust any of the internal controls due to circuit changes caused by component aging or replacement, refer to the calibration section of this instruction manual.

2.3 OPERATION

2.3.1 Control Settings

Set all coarse and fine output controls fully CCW and set the meter select switch to V.

2.3.2 Grounding

Either side of either output may be grounded or the outputs may be used in a floating condition.

2.3.3 Power On

Connect the power supply to a nominal AC power source. Set power switch S1 to AC-ON, and observe that pilot lamp DS1 glows.

2.3.4 Warm-Up

No warm-up time is necessary to place the unit into operation. However, a 30 minute warm-up period is recommended to reach rated stability.

CHAPTER 3

THEORY OF OPERATION

3.1 GENERAL

The purpose of the Model TL8-3 Triple Output Lab Series Power Supply is to transform and rectify the AC input into a well regulated, stable and adjustable DC output. The following paragraphs describe the major circuits. As each circuit is described, reference should be made to the schematic diagram in the rear of this manual.

3.1.1 Primary Input

Input power is obtained through transformer T101 full wave rectifier diode sets CR1,CR10; CR2,CR11; CR19,CR20 and filter capacitors C3, C10 and C17.

When AC power switch S1 is set to AC-ON, AC pilot lamp DS101 glows, and AC power is applied to T101. Regulated DC output power is immediately available.

3.1.2 Reference Supplies

The C3 voltage appears across the +12V, +10V and +6.2V reference supplies. These reference voltages are, in turn, developed across CR25, CR5 and CR6, respectively.

The C10 voltage appears across the -12V, -10V and -6.2V reference supplies. These reference voltages are, in turn, developed across CR26, CR14 and CR15, respectively.

3.1.3 Series Regulator

The rectified and filtered voltages from the three input rectifier sections are directed through each of the respective series pass transistors. The conduction of each of these transistors is controlled by independent circuitry which causes them to act as variable resistors. Their overall resistance varies in accordance with the need of the Power Supply to increase or decrease the output voltage.

Each pass transistor is controlled by a driver transistor which is, in turn, controlled by the corresponding voltage (error) amplifier.

3.1.4 Voltage (Error) Amplifier

The theory of operation for all three voltage amplifiers is identical. A sample of the output voltage is compared with a stable reference (see reference supplies) at the base of the input stage of the amplifier. An unbalance caused by a voltage change at either the output terminals or across the output control potentiometers will appear as a voltage change at the collector of the first stage. For example, an increase in output causes the first stage to turn off, turning on the second transistor, turning off the third transistor and turning off the driver transistor. This causes the pass to be turned off off and the output voltage to decrease.

3.1.5 Current Limit Circuit

In the case of all three current limit circuits, a voltage drop is sensed across a small resistance in series with each output. As current increases, this voltage drop increases, eventually turning on a transistor in its current limit circuit which turns off the first stage of the voltage amplifier for this output. This has the overall effect of independently shutting down this output.

3.2 OPTIONAL FEATURES

3.2.1 Overvoltage (OV) Protection

If the output voltage should use over the threshold set by the OV potentiometer, the OV sensing transistor will turn on, turning on the SCR driver. This applies a signal to the gate of the SCR causing it to "fire" and place a "crowbar" across the output. This short circuits the output and activates the current limit circuit which turns off the pass transistor.

CHAPTER 4

MAINTENANCE

4.1 GENERAL

This Power Supply is a precision instrument. It is strongly recommended that only experienced troubleshooting personnel perform troubleshooting operations or attempt to repair the unit. If the Pow Power Supply appears to be malfunctioning at all, the following procedure is recommended for isolating possible defects.

4.2 LOADS AND INTERCONNECTIONS

1. Disconnect all interconnections and loads to which the unit is normally connected.

2. Connect a separate resistive dummy load across each output terminal. This load should be of sufficient value to allow the unit to operate at its maximum rated current and voltage output.

3. Apply nominal AC input power to the unit and check for normal operation. Satisfactory operation at this time would indicate that any malfunction previously encountered, is external in nature. All interconnections and loads normally used in conjunction with this Power Supply should then be carefully checked for electrical defects.

WARNING

High Voltages are presetn use caution.

4.3 TROUBLESHOOTING

1. Set VOLTAGE ADJUST and VOLTAGE VERNIER controls fully CW. Using a 20,000Ω per volt voltmeter or oscilloscope, check the voltages across the various circuit components listed in the Troubleshooting Guides, located in this Chapter. The sample voltages listed in this guide apply only if the unit is operating at its nominal AC input, and has no load on any output unless otherwise specified. Any reading which is grossly incorrect, indicates that the stage being tested or the one im ediately preceding it, is defective. The Schematic Diagram and appropriate sections of the Theory of Operation will prove helpful in any troubleshooting work. Proper polarity to be observed when testing can be easily obtained from the Schematic Diagram.

2. If voltage checks show no noticable deviations from the prescribed values, disconnect AC power and proceed with point-to-point resistance checks across potentiometers, switches, diodes, resistors, transistors in that order.

3. When the trouble is of an intermittent nature, such as poor regulation, ripple, etc., the use of an oscilloscope to determine dynamic changes will be necessary.

TROUBLESHOOTING GUIDE - 0 to +32V OUTPUT

Sympton	Possible Problem Area	
Zero output voltage	AC Input Section	If the AC power lamp (DS101) is off, one or more of the components listed has probably failed. F101 open circuit; S101 open circuit; S102 open circuit.
Zero or small negative output voltage	Rectifier Section or -6.2V and -10V Reference Section	Measure the voltages across the following components. Check the levels measured with those below: C3 26V; CR14 10V; CR15 6.2V
	Series Pass and Driver Section	Measure the voltage drop across the base to emitter junction of Q101 and Q3 (across R9 and R6). Both transistor junctions should be forward biased.
	Voltage Amplifier Circuit	The base to emitter voltages of Q20, Q5 and Q6 should be about 0.6 VDC, in the forward direction for that transistor.
Zero or small positive output voltage	Current Limit Circuit	If the voltage across R14 is approximately zero, then Q4 should be cutoff and cR7 reversed biased. If the voltage across R14, is significant, then there is current flowing in the supply. The output terminals are probably shorted to common.
Large and Unregulated Output Voltage	Series Pass Driver Section or Voltage Amplifier Circuit	Check Q101 for collector emitter short Check Q3 for collector emitter short Check Q20 for collector emitter short Check Q6 for collector emitter short Check Q5 for collector emitter open
Output does not current limit	Voltage Amp. Circuit or Current Limit Circuit or -12V Reference Section	Probably Q4 has failed open and/or CR7 has failed open. Measure the voltage across CR26, the level is approximately 12V.
Overload lamp does not turn on on when currnet	Overload Lamp Logic Circuit	Check for failure of DS102 overload lamp. With the supply in current limit operation, the base to emitter voltage of Q21 and Q1 should be about 0.6V in the forward direction.
Overload lamp always on	Overload Lamp Logic Circuit	Check Q21 for collector emitter short Check Q1 for collector emitter short (Ensure that no other output is in current limit) Check Q24 for collector emitter short Check Q23 for collector emitter short

TROUBLESHOOTING GUIDE - 0 to -32V OUTPUT

Symptom	Possible Problem Area	
Zero or small positive output voltage	Rectifier Section or -6.2V and -10V Reference Section	Measure the voltage across the following components. Check the levels measured with those indicated bloow: C10 26V; CR5 10V; CR6 6.2V
	Series Pass and Driver Section	Measure the voltage drop across the base to emitter junction of Q102 and Q8 (across R32 and R33). Both transistor junctions should be forward biased.
	Voltage Amplifier Circuit	The base to emitter voltages of Q9, Q11 and A12 should be about 0.6 VDC, in the forward direction for that transistor.
Zero or small negative output voltage	Voltage Amp. Circuit or Current Limit Circuit	If the volt age across R47 is approximately zero, then Q10 should be cutoff and CR16 reversed biased.
	Current Limit Circuit	If the voltage across R47 is significant, then there is current flowing in the supply. The output terminals are probably shorted to common.
Large and unregulated output voltage	Series Pass and Driver Section or Voltage Amp. Circuit	Check Q102 for collector emitter short Check Q8 for collector emitter short Check Q9 for collector emitter short Check Q12 for collector emitter short Check Q11 for collector emitter open
Output does not current limit	Voltage Amp. Circuit or Current Limit Circuit or +12V Reference Section	Measure the voltage across CR25, this is approximately 12V. Possible Q10 has failed open and/or CR16 has failed open.
Overload lamp does not turn on when current limiting	Overload lamp Logic Circuit	Check for failure of DS102 overload lamp. With the supply in current limit operation, the base to emitter voltage of Q21 and Q24 should be about 0.6V in the forward direction.

TROUBLESHOOTING GUIDE - 0 to +8V OUTPUT

Sympton	Possible Problem Area	
Zero or small negative output voltage	Rectifier Section or -6.2V and -10V Reference Section	Measure the voltage across the following components. Check the levels measured with those indicated below (at no load). C17 17.5V; CR14 10V; CR15 6.2V.
	Series Pass and Driver Section	Measure the voltage drop across the bias to emitter junction of Q103 and Q13 (across R57 and R56). Both transistor junctions should be forward biased.
	Voltage Amp. Circuit	The base to emitter voltage of Q15, Q16 and Q17 should be about 0.6 VDC, in the forward direction for that transistor.
Zero or small positive output voltage	Current Limit Circuit	If the voltage across R65 and R98 is approximately zero, then Q14 and Q23 should be cutoff. The base to emitter junction of Q23 should be reversed biased.
	Current Limit Circuit or Overvoltage Circuit	If the voltage across R65 and R98 is significant, then there is current flowing in the supply. The output terminals are probably shorted together, possibly by the overvoltage circuit.
Large and unregulated output voltage	Overvoltage circuit AND	Set R74 fully CW. The base to emitter voltages of Q18 and Q19 should be approximately 0.6V forward biased. Q19 collector should be equal to the observed output.
	Series Pass and Di Driver Section or Voltage Amp. Circuit	Check Q103 for collector emitter short Check Q13 for collector emitter short Check Q15 for collector emitter short Check Q17 for collector emitter short Check Q16 for collector emitter open
Overvoltage triggers, even though output is normal and R74 is set fully CCW	Overvoltage Circuit or -12V Reference Section	Check Q18 for collector emitter short Check Q19 for collector emitter short Measure the voltage across CR26; the level should be 12V.
Output does not current limit	Current Limit Circuit or +12V or -12V Reference Section	Q14 failed open or CR23 failed opan. Measure the voltage across the following components. Check the levels measured with those indicated below: CR25 12V; CR26 12V.
Overload lamp does not light during current limiting	Overload lamp logic circuit	Check for failure of DS102 (overload lamp). With the supply in current limit operation, the base to emitter voltage of Q21 and Q1 should be about 0.6V forward biased.

CHAPTER 5

CALIBRATION

5.1 GENERAL

The following adjustments should be made when necessary to assure optimum operating characteristics and maximum efficiency of this Power Supply.

5.2 TEST EQUIPMENT REQUIRED (Or Equivalent)

1. Oscilloscope, Tektronix Type 561.
2. Differential Amplifier Plug-In, Tektronix Type 63.
3. Time Base Plug-In, Tektronix Type 67.
4. Differential VTVM, Fluke Model 825A.
5. DC Ammeter, Weston Model 901.

5.3 CALIBRATION PROCECURE

1. Maximum Voltage - Set Front Panel "V ADJ" fully clockwise, and "FINE" fully counter clockwise for all three outputs. Adjust maximum voltage control R92 (0 to +32V), R93 (0 to -32V) and R94 (0 to +8V) to obtain the maximum rated output voltage for each output.

2. (0 to +8V) Maximum Current - Set output voltage equal to 8.00 VAC ±10 mV. Monitor Vout with a scope (10 mV/cm scale). Rotate the current adjust potentiometer (R59) fully clockwise. With an external DC current meter and a variable load adjust the output current to 3.3 amps ±100 mA. Slowly rotate R59 in the counter clockwise direction until an affect is seen on the output voltage. Check the setting by adjusting the variable for maximum current. The maximum current the unit should be capable of is 3.3 amps.

3. Meter Circuit - Place the meter select switch in the Volts position. Adjust each output to its maximum voltage ±20 mV. (Differential VTVM, Fluke Model 825A is recommended). Calibrate each meter by adjusting the meter face screw for the last division of the meter scale.

Place the meter select switch in the amps position, then load down one output at a time. Monitor the output current carefully with an accurate DC current meter. For the 0 to +32V output, adjust R16 so both the "A" meter and the reference meter indicate the same current. For the 0 to -32V output, calibrate the "B" meter by adjusting R50, Finally calibrate the "C" meter with R54.

CHAPTER 6

REPLACEABLE PARTS

6.1 INTRODUCTION

This chapter contains the spare parts lists for the Model TL8-3 Triple Output Lab Series Power Supply. Ordering information is included and should be used when purchasing parts from the factory. Explanation of the column listings and Table 6-1 Manufacturers Code-To-Name Index are also included.

6.2 PART ORDERING INFORMATION

To order a part from the Replaceable Parts List, state the Systron-Donner part number, indicate the quantity required and address the order to the nearest Systron-Donner Sales or Service Center.

To order a part not listed in the Replaceable Parts List, state the instrument model number, instrument serial number, the description and function of the part, and the number of parts required. Address the order to the nearest Systron-Donner Sales or Service Center.

6.3 PARTS LISTS

Table 6-1 gives the Code-To-Name information for the manufacturers listed in the replaceable parts lists. The replaceable parts lists are placed in a numbered sequence.

Each column in the parts lists provide specific information relating to the listed parts as follows:

(1) DESIGNATOR: Reference numbers applicable to assemblies are listed in alpha-numeric order.

(2) COMPONENT NOMENCLATURE AND DESCRIPTION: Component names and specifications are provided in these columns and include; value, tolerance, wattage rating, working voltage, construction, etc.

(3) MANUFACTURER'S CODE: H4-2 Federal Supply Code numbers are listed to identify component manufacturers. A Manufacturers Index is provided in this Chapter for cross-reference.

(4) MANUFACTURER'S PART NUMBER: True Manufacturer part numbers are listed in this column.

(5) SD STOCK NUMBER: The Systron-Donner stock number is listed in this column.

(6) T/Q (Total Quantity): This quantity, appearing after an item entry, indicates the number of times the component is used in that assembly. The total quantity for each part is given only once - at the first appearance of the part number.

TABLE 6-1 MANUFACTURER'S CODE-TO-NAME INDEX

CODE	NAME & ADDRESS
00853	Sangamo Electric Co. So. Carolina Division P.O. Box 128 Pickens, S.C. 29671
01121	Allen-Bradley Co. 1201 So. 2nd St. Milwaukee, WI 53204
02763	Grippe Machining & Mfg. Co. 15642 Common Rd. Roseville, MI 48066
03877	Transitron Electronic Corp. 168 - 186 Albion St. Wakefield, MA 01880
04713	Motorola Semiconductor Prod. Inc. 5005 E. McDowell Rd. Phoenix, AZ 85008
05245	Components Corp. 2857 N. Halsted St. Chicago, IL 60657
05820	Wakefield Engineering, Inc. Audubon Road Wakefield, MA 01880
06383	Panduit Corp. 17301 Ridgeland Tinley Park, IL 60477
06540	Amatom Electronic Hardware Division of Mite Corp. 81 Rockdale Ave. New Rochelle, N.Y. 10806
07047	Ross Milton Co. 511 Second St. Pike Southampton, PA 18966
07088	Kelvin Electric Co. 5907 Noble Ave. Van Nuys, CA 91401
08289	Delbert Blinn Co. Inc. P.O. Box 2007 1678 Mission Blvd. Pomona, CA 91766
08530	Reliance Mfg. Co. Inc. 342 - 39th St. Brooklyn, N.Y. 11232
11236	CTS of Berne Inc. 406 Parr Rd. Berne, IN 46711
12136	Philadelphia Handle Co. Inc. 1643 Haddon Ave. Camden, N.J. 08103
14604	Elmwood Sensors Inc. 1655 Elmwood Ave. Cranston, R.I. 02907
15915	Tepro of Florida Inc. 2608 Enterprise Rd. Dunedin, FL 33528
17117	Electronic Molding Corp. 96 Mill St. Woonsocket, RI 02895
26466	Carter Electronics Corp. 6762 Greenville Ave. Dallas, Texas 75231
52542	Systron-Donner Corp. Instrument Division 10 Systron Drive Concord, CA 94518
54453	Sullins Electronic Corp. P.O. Box 757 275 Pico Ave. San Marcos, CA 92069
56289	Sprague Electronic Co. North Adams, MA 01247
57771	E.B. Stimpson Co. Bayport, N.Y. 11705
58474	Superior Electric Co. 383 Middle St. Bristol, CT 06010
61957	United Shoe Machinery Corp. Boston, MA
71590	Centralab Electronics Division of Globe-Union Inc. 5757 No. Green Bay Ave. Milwaukee, WI 53201
72982	Erie Technological Prod. Inc. 644 W. 12th St. Erie, PA 16512
75042	TRW Electronic Components 401 No. Broad St. Philadelphia, PA 19108
75915	Littlefuse Inc. 800 E. Northwest Hwy. Des Plaines, IL 60016

TABLE 6-1 MANUFACTURER'S CODE-TO-NAME INDEX (Cont'd)

CODE	NAME & ADDRESS
76381	Minnesota Mining & Mfg. Co. . 3 M Center, St. Paul MN 55101
76493	J.W. Miller Co. P.O. Box 5825 Compton, CA 90224
78553	Tinnerman Products Inc. 8700 Brookport Rd. Cleveland, OH 44129
81349	MIL STD
83330	Herman H. Smith Inc. 812 Snediker Ave. Brooklyn, N.Y. 11207
83777	E-Systems Inc. 41 E. Park Dr. Huntington, IN 46750
86797	Rogan Corp. 3455 Woodhead Dr. Northbrook Dr. 60062
88625	Keystone Electronic Corp. 2801 Grant Ave. Philadelphia Ind. Park Philadelphia, PA 19114
91802	Industrial Devices Inc. 982 River Rd. Edgewater, N.J. 07020
96906	MIL STD
98278	Malco Microdot Co. Inc. Connector & Cable Division 220 Pasadena Ave. So. Pasadena, CA 91030

REPLACEABLE PARTS LIST

TITLE		MODEL TL8-3 OV SHIPPING ASSEMBLY T50400				
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		ASSEMBLY, Case	52542	PD21561	PD21561	1
		CASE	52542	104063	104063	1
		FEET, Rubber	76493	2096W	840192	4
		HANDLE	12136	919-414-173	T920050	1
		STRIP, Insulator	76381	4116	T950174	1
		RIVETS	61957	AD42-A-BS-1/8	T960345	A/R
		CHASSIS ASSEMBLY	**52542**	**PD21553**	**PD21553**	**1**
		CHASSIS	52542	065019	065019	1
	T101	TRANSFORMER	52542	504303	504303	1
		HOLDER, Fuse	75915	345001	117377	1
	F101	FUSE, 2.5A 125V	95915	31302.5	870175	1
		LABEL, Fuse	52542	780639	780639	1
		CORD, Line	70903	BR-1736	102407	1
		RECEPTICAL, AC	02660	225-22821-103	101288	1
		LABEL, Input 115 VAC	52542	065096-2	065096-2	1
		SPACER, Hex	06540	9224-B-140-4	860296	4
		STANDOFF, 6-32	17117	3023-91-1	860070	1
		NUT, Speed	78553	C6452-632-1	T981037	8
		NUT, Speed	78553	C9807-832-4	T981043	2
		LUG, Solder #6	83330	1410-6	T960110	2
		HEATSINK ASSEMBLY	**52542**	**PD21550**	**PD21550**	**1**
		HEATSINK	52542	T104072	T104072	1
	Q101	TRANSISTOR	04713	2N2223	705071	3
	Q102	Same as Q101				
	Q103	Same as Q101				
		SOCKET, Transistor	88625	4601	830101	3
		WASHER, Mica	08289	DM-01	T990290	3
	S102	SWITCH, Thermal 135°C	14604	2450-88-16	880007	1
		FRONT PANEL ASSEMBLY	**52542**	**PD21549**	**PD21549**	**1**
		PANEL, Front Finish	52542	T104104	T104104	1
	DS101	LIGHT, Pilot Red	91802	2110A(Red)	770024	1
	DS102	LIGHT, Pilot White	91802	2190A87	770023	1
	J2	POST, Binding Green	83330	1517-104	T920186	1
	J3	POST, Binding Yellow	83330	1517-Yellow	T920185	1
	J4	POST, Binding Red	58474	DF21RC	T102646	1
	J5	POST, Binding Black	58474	DF21BC	102647	1
	J6	POST, Binding White	58474	DF21WTC	102648	1
	M1	METER, Green +32V	52542	753135	753135	1
	M2	METER, Yellow -32V	52542	753140	753140	1
	M3	METER, Red +8V	52542	753130	753130	1
	S101	SWITCH, ON-OFF	52542	880015	880015	1
		KNOB, W/Line	86797	RB-67-1-M-9	T920072	1
		KNOB, Plain	86797	RB-67-1-M	T920073	6

REPLACEABLE PARTS LIST

TITLE	MODEL TL8-3 OV SHIPPING ASSEMBLY T50400 (Cont'd)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
		PC BOARD ASSEMBLY	**52542**	**PD21547**	**PD21547**	**1**
	C1	CAPACITOR, Ceramic .05 μF 200V	72982	845-024	800168	7
	C2	Same as C1				
	C3	CAPACITOR, El Ax 1600 μF 60V	00853	066XJL162W0608	819953	2
	C4	CAPACITOR, Ceramic .01 μF 600V	71590	DD6-103	800090	2
	C5	CAPACITOR, Ceramic .022 μF 500V	72982	841-000-25V2032	106489	3
	C8	Same as C1				
	C9	Same as C1				
	C10	Same as C3				
	C11	Same as C1				
	C15	Same as C1				
	C16	Same as C1				
	C17	CAPACITOR, El Ax 5500 μF 8V	00853	066JS552-W0188	819985	1
	C18	Same as C4				
	C19	Same as C5				
	C21	CAPACITOR, DM 50 pF 600V	56289	10TS-Q50	800003	1
	C22	Same as C5				
	C23	CAPACITOR, Ceramic .0047 μF 10%, 600V	71590	CE-472	800050	2
	C26	CAPACITOR, Ceramic 3300 pF 10%, 600V	71590	CE-332	800025	1
	C27	Same as C23				
	C28	CAPACITOR, Chip Disc 100 pF 20%, 600V	05245	CK60BX101M	800007	1
	CR1	DIODE, Rectifier 400V	26466	1N4385	720384	4
	CR2	Same as CR1				
	CR3	DIODE, Zener 5.6V	03877	1N752A	100376	1
	CR4	DIODE, Signal 75V	04713	1N4148	720440	11
	CR5	DIODE, Zener 10V	04713	1N961B	100395	4

TITLE MODEL TL8-3 OV SHIPPING ASSEMBLY T50400 (Cont'd)

ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	CR6	DIODE, Reference 6.2V	81349	1N823	720461	2
	CR7	Same as CR4				
	CR8	Same as CR4				
	CR10	Same as CR1				
	CR11	Same as CR1				
	CR12	Same as CR4				
	CR13	Same as CR5				
	CR14	Same as CR5				
	CR15	Same as CR6				
	CR16	Same as CR4				
	CR17	Same as CR4				
	CR19	DIODE, Rectifier 100V	04713	1N4720	720454	2
	CR20	Same as CR19				
	CR21	Same as CR4				
	CR23	Same as CR4				
	CR25	DIODE, Zener 12V	04713	1N963B	100390	2
	CR26	Same as CR25				
	CR28	Same as CR5				
	CR29	Same as CR4				
	CR30	Same as CR4				
	CR31	Same as CR4				
	F3	FUSE, 4A 250V	75915	312004	871017	1
	Q1	TRANSISTOR, PNP Silicon	07263	2N2905A	705067	8
	Q2	Same as Q1				
	Q3	Same as Q1				
	Q4	Same as Q1				
	Q5	TRANSISTOR, PNP Silicon	07263	2N3638A	700002	5
	Q6	Same as Q5				
	Q7	TRANSISTOR	07263	2N2219A	705068	4
	Q8	Same as Q7				
	Q9	Same as Q1				
	Q10	Same as Q7				

REPLACEABLE PARTS LIST

TITLE	MODEL TL8-3 OV SHIPPING ASSEMBLY T50400 (Cont'd)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	Q11	TRANSISTOR, Silicon 30V	81349	2N3566	700182	3
	Q12	Same as Q11				
	Q13	Same as Q1				
	Q14	Same as Q1				
	Q15	Same as Q11				
	Q16	Same as Q5				
	Q17	Same as Q5				
	Q20	TRANSISTOR, NPN Silicon	07263	2N3440	101420	2
	Q21	Same as Q20				
	Q22	Same as Q7				
	Q23	Same as Q1				
	Q24	Same as Q5				
	R1	RESISTOR, CC 15 k 5%, 1/2W	01121	EB1535	105000	4
	R2	RESISTOR, CC 1.2 k 5%, 1/2W	01121	EB1225	101455	3
	R3	RESISTOR, WW 2.5 k 3%, 3W	15915	TS3 2.5K3%	630450	1
	R4	RESISTOR, MF 200 Ω 1%, 1/2W	81349	RN65D2000F	620070	1
	R5	RESISTOR, MF 274 Ω 1%, 1/2W	81349	RN65D2740F	620095	1
	R6	RESISTOR, CC 330 Ω 5%, 1/2W	01121	EB3315	101474	7
	R7	Same as R2				
	R8	RESISTOR, CC 27 k 5%, 1/2W	01121	EB2735	101517	6
	R9	RESISTOR, CC 68 Ω 5%, 1/2W	01121	EB6805	102238	3
	R10	RESISTOR, MF 15 k 1%, 1/2W	81349	RN65D1502F	620627	2
	R11	RESISTOR, MF 523 Ω 1%, 1/2W	81349	RN65D5230F	620193	2
	R12	RESISTOR, CC 220 k 5%, 1/2W	01121	EB2245	101458	1

REPLACEABLE PARTS LIST

TITLE	MODEL TL8-3 OV SHIPPING ASSEMBLY T50400 (Cont'd)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	R13	RESISTOR, WW 5 k 5%, 5W	83777	VL55.0K	640551	2
	R14	RESISTOR, WW 2 Ω 3%, 5W	07088	KM500-2	630065	2
	R17	RESISTOR, CC 100 k 5%, 1/2W	01121	EB1045	101480	2
	R18	RESISTOR, CC 6.8 k 5%, 1/2W	01121	EB6825	101510	1
	R19	RESISTOR, CC 82 k 5%, 1/2W	01121	EB8235	101502	1
	R20	RESISTOR, CC 3.3 k 5%, 1/2W	01121	EB3325	101432	3
	R22	RESISTOR, CC 10 k 5%, 1/2W	01121	EB1035	101471	3
	R23	Same as R6				
	R24	Same as R8				
	R25	RESISTOR, MF 750 Ω 1%, 1/2W	81349	RN65D7500F	620250	2
	R28	RESISTOR, CC 22 k 5%, 2W	01121	HB2235	102217	1
	R29	RESISTOR, MF 340 Ω 1%, 1/2W	81349	RN65D3400F	620130	1
	R30	RESISTOR, MF 243 Ω 1%, 1/2W	81349	RN65D2430F	620076	1
	R31	RESISTOR, CC 1 k 5%, 2W	01121	HB1025	101747	1
	R32	Same as R9				
	R33	Same as R6				
	R34	Same as R2				
	R35	Same as R10				
	R36	RESISTOR, CC 39 k 5%, 1/2W	01121	EB3935	101469	1
	R37	Same as R11				
	R38	Same as R8				
	R39	RESISTOR, CC 22 k 5%, 1/2W	01121	EB2235	101513	1
	R40	Same as R20				

TITLE	MODEL TL8-3 OV SHIPPING ASSEMBLY T50400 (Cont'd)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	R41	Not Used				
	R42	Same as R1				
	R43	Same as R22				
	R44	Same as R8				
	R45	Same as R25				
	R47	Same as R14				
	R48	Same as R13				
	R52	RESISTOR, WW 3 k 5%, 5W	83777	VL53.0K	640546	1
	R56	RESISTOR, CC 390 Ω 5%, 1/2W	01121	EB3915	101476	1
	R57	Same as R9				
	R58	RESISTOR, MF 174 Ω 1%, 1/2W	81349	RN65D1740F	620055	1
	R59	RESISTOR, Variable 100 Ω 20%, 1.5W	11236	110	600062	1
	R60	Same as R20				
	R61	RESISTOR, CC 820 Ω 5%, 1/2W	01121	EB8215	101656	1
	R62	RESISTOR, MF 4.87 k 1%, 1/2W	81349	RN65D4871F	620545	1
	R63	RESISTOR, CC 2.7 k 5%, 1/2W	01121	EB2725	101436	1
	R64	RESISTOR, CC 56 k 5%, 1/2W	01121	EB5635	101433	1
	R65	RESISTOR, WW .7 Ω 3%, 5W	07088	KM500-.7	630025	2
	R66	Same as R8				
	R67	Same as R17				
	R68	Same as R6				
	R69	Same as R6				
	R71	RESISTOR, MF 3.01 k 1%, 1/2W	81349	RN65D3011F	620480	1
	R72	Same as R22				
	R81	RESISTOR, CC 1.2 k 5%, 1W	01121	GB1225	101506	1

REPLACEABLE PARTS LIST

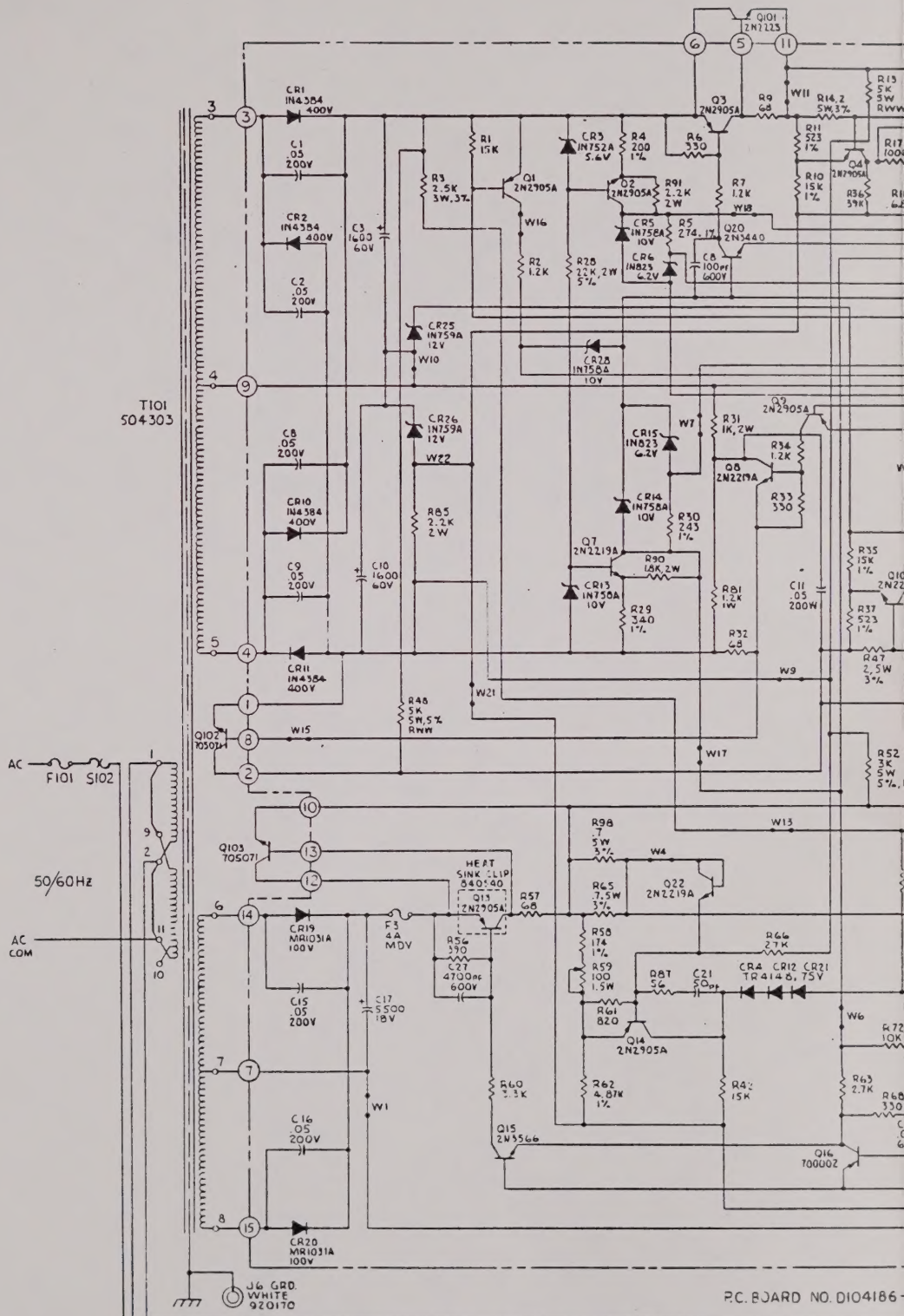
TITLE	MODEL TL8-3 OV SHIPPING ASSEMBLY T50400 (Cont'd)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	R82	Same as R1				
	R83	Same as R1				
	R84	Same as R8				
	R85	RESISTOR, CC 2.2 k 5%, 2W	01121	HB2225	101524	2
	R87	RESISTOR, CC 56 Ω 5%, 1/2W	01121	EB5605	101526	1
	R88	Same as R6				
	R89	RESISTOR, CC 1 k 5%, 1/2W	01121	EB1025	101467	1
	R90	RESISTOR, WW 1.8 k 2W	75042	BWH	640528	1
	R91	Same as R85				
	R92	RESISTOR, Variable 500 Ω 20%, 2W	11236	1377428	600142	2
	R93	Same as R92				
	R94	RESISTOR, Variable 2 k 10%, 2W	11236	1377430	600223	1
	R96	RESISTOR, CC 1.8 k 5%, 1/2W	01121	EB1825	101466	1
	R98	Same as R65				
		PAD, Transistor	07047	10079-DAP	840420	22
		HEATSINK	05820	207CB	100746	1
		TIE, Wrap	06383	SST1.51	101115	3
		TERMINAL	88625	1540-2	T960464	34
		TERMINAL	98278	001-0091-003	543131	15
		TERMINAL	88625	1257	T960574	14
		EYELET	07707	SE46	112572	14
		JUMPER	52542	PD21546	PD21546	1
		HARNESS	52542	PD2154401	PD2154401	1
		BOARD, PC	52542	104181	104181	1
		METER ASSEMBLY	**52542**	**PD21593**	**PD21593**	**1**
	C6	CAPACITOR, Tant 15 μF 20%, 35V	81349	DNS156C035MR	821027	2
	C7	CAPACITOR, El Ax 91 μF -10%+50%, 40V	52542	810117	810117	2
	C12	CAPACITOR, El Ax 300 μF, 15V	00853	557DG301U015BE	810182	1

REPLACEABLE PARTS LIST

TITLE	MODEL TL8-3 OV SHIPPING ASSEMBLY T50400 (Cont'd)					
ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	C13	Same as C6				
	C14	Same as C7				
	C20	CAPACITOR, Tant 5.6 μF, 20V	81349	DNS565802KR	821018	1
	C25	CAPACITOR, Ceramic .05 μF, 200V	72982	845-024	800168	1
	CR9	DIODE, Rectifier 400V	26466	1N4384	720384	3
	CR18	Same as CR9				
	CR24	DIODE, Rectifier 400V	04713	1N4384	720453	1
	CR27	DIODE, SCR	04713	2N4441	725138	1
	J1	CONNECTOR, PC	54453	ISM22DRKH-S50	102806	1
	Q18	TRANSISTOR, Silicon	07263	2N3566	700182	1
	Q19	TRANSISTOR, PNP Silicon	02763	2N3638A	700002	1
	R15	RESISTOR, CC 2.7 k 5%, 1/2W	01121	EB2725	101436	2
	R16	RESISTOR, Variable 750 Ω 10%, 12W	11236	1377502	600151	2
	R21	RESISTOR, Variable 150 Ω 20%, 2W	11236	116&Shaft	600063	3
	R26	RESISTOR, MF 31.9 k 5%, 1/2W	81349	RN65D3192F	620685	2
	R27	RESISTOR, Variable 5 k 10%, 2W	52542	600299	600299	3
	R46	Same as R27				
	R49	Same as R15				
	R50	Same as R16				
	R51	Same as R26				
	R53	RESISTOR, CC 820 Ω 5%, 1/2W	01121	EB8215	101656	1
	R54	RESISTOR, Variable 500 Ω 10%, 1.5W	11236	1377438	600146	1
	R55	RESISTOR, MF 7.9 k 1%, 1/2W	81349	RN65D7901F	620605	1
	R70	Same as R21				
	R73	Same as R27				

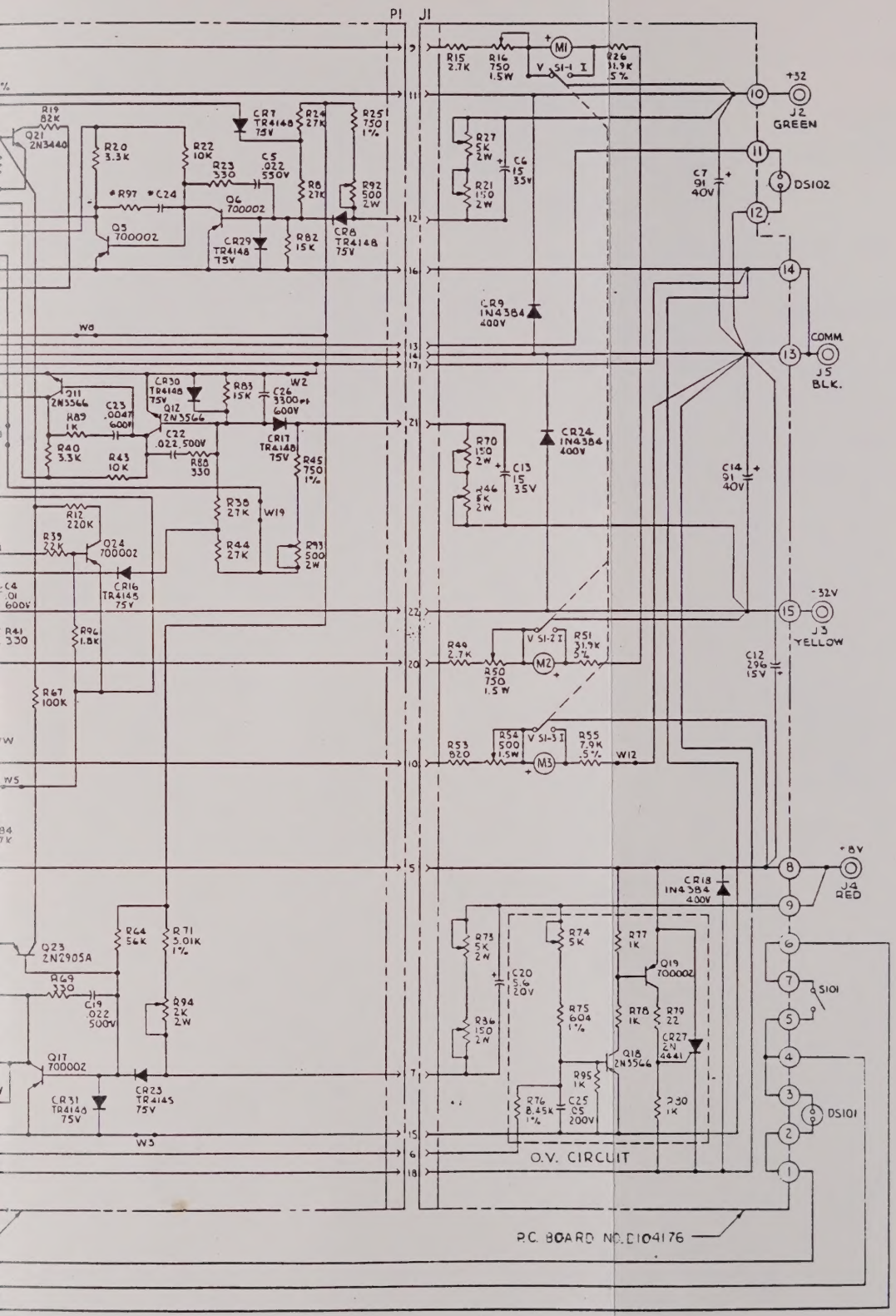
TITLE: MODEL TL8-3 OV SHIPPING ASSEMBLY T50400 (Cont'd)

ITEM	REF	COMPONENT DESCRIPTION	MFR'S CODE	MANUFACTURER'S PART NUMBER	SD STOCK NUMBER	T/Q
	R74	RESISTOR, Variable 5 k 10%, 3/8W	73138	89PR5K	102473	1
	R75	RESISTOR, MF 604 Ω 1%, 1/2W	81349	RN65D6040F	620210	1
	R76	RESISTOR, MF 8.45 k 1%, 1/2W	81349	RN65D8451F	620598	1
	R77	RESISTOR, CC 1 k 5%, 1/2W	01121	EB1025	101467	4
	R78	Same as R77				
	R79	RESISTOR, CC 16 Ω 5%, 1/2W	01121	EB1605	106001	1
	R80	Same as R77				
	R86	Same as R21				
	R95	Same as R77				
	S1	SWITCH, Rotary	52542	880650	880650	1
		EYELET	57771	A2085	T960663	17
		WAFER, Rotary Switch	52542	880651	880651	1
		PAD, Transistor	07047	10079-DAP	840420	2
		RING, Insulator	08530	554-620L	T990309	1
		WASHER, Mica	08530	561-6201	T990311	4
		WASHER, Nylon	83330	2515	T990330	4
		BOARD, PC	52542	104176	104176	1



NOTES

1. UNLESS OTHERWISE SPECIFIED :
   ALL RESISTORS ARE IN OHMS, 1/2 WATT 5%.
   ALL CAPACITORS ARE IN MICROFARADS.
2. * DENOTES FACTORY SELECT.
3. TRANSFORMER SHOWN STRAPPED FOR 115/120V OPERATION
   FOR OTHER PRIMARY VOLTAGES SEE CHART.



ARY AGES	TRANSFORMER CONNECTIONS JUMPER	A C COM TO	F101 FUSE
0	1-9 2-11	10	2.5A-SB
120	1-9 2-11	11	2.5A-SB
/220	9-2	10	1.5A-SB
/240	9-2	11	1.5A-SB

MODEL TL8-3-0V

SCHEMATIC